PLANETARY GEOLOGIC MAP UNITS: LIMITATIONS AND IMPLEMENTATION

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Introduction: The goal of geologic mapping is to reconstruct the geologic history of a study area with the objective of understanding the evolutionary processes and controls involved. Maps attempt to characterize and organize spatial and temporal geologic data, which includes stratigraphy and tectonic, volcanic, erosional, and depositional entities. We must appreciate that the geology is more complex than can be fully realized and represented on a geologic map. Another problem is that relative-age correlations of map units and structures in some instances are poorly constrained. Therefore, geologic mappers need to discuss methodologies and acknowledge critical uncertainties and avoid over-interpretation and bias. A fundamental issue is how map units are defined, mapped, and relative-age dated.

Limitations: In planetary mapping, we have inherent limitations in available data, which dictates what can reasonably be achieved. Importantly, we do not have field data to work with, but terrestrial field experience is essential to properly apply spacecraft data to photogeologic mapping. The image base provides the primary data used for mapping. Data quality and resolution commonly vary from place to place. Also, environmental aspects can be variable, such as atmospheric and illumination conditions. Other available types of data (e.g., spectra, altimetry, radar, and geophysical) may enhance the observations that can be made. In many instances, planetary map units cannot be made to represent rock-stratigraphic units in a strict sense. Instead, they may define modified *terrains* that may correspond to *rock* units.

Implementation: Rock-stratigraphic units are the preferred unit type, but secondary characteristics many times have to be used as a basis for deciphering the geologic and resurfacing history. Units based solely on secondary features represent modified rock materials of uncertain makeup and relative age. Thus in some cases, a map unit may comprise rocks of multiple ages and origins; in other cases, multiple map units represent different modificational states of a single rock material. All of these issues should be adequately described in the map text and properly portrayed on the geologic map (e.g., solid vs. dashed contacts and contact triple junctions) and correlation chart (e.g., saw-tooth boundaries), such that the results are reproducible.

In order to reflect temporal relations accurately, map-unit correlation charts must show relative ages of the features used to define the unit. For units based on secondary characteristics, the relative ages of the modificational features constrain the upper age of the material(s) they modify. But the actual upper age of the material may be much older than the secondary features. In some cases, adjacent, less-modified units may include similar characteristics that provide a basis for inference of contemporaneity with the modified unit. These and other situations illustrate that material and relative-age information of map units may vary greatly and be sorely lacking in many cases. Cross sections can show relations among stratigraphy and structure. Additional columns on the correlation chart may be used to show the time of formation of modificational landforms, which will assist with understanding what the map-unit boxes in the chart represent. The mapping of both rock and modified units, though disconcerting to the purist, cannot be avoided in planetary mapping and, when thoughtfully performed, can result in a greater understanding of the geologic history of the region of interest.